Physiological and anthropometric characteristics of amateur rugby league players

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Abstract

***Objectives*—To investigate the physiological and anthropometric characteristics of amateur rugby league players.**

***Methods*—Thirty five amateur rugby league players (19 forwards and 16 backs) were measured for height, body mass, percentage body fat (sum of four skinfolds), muscular power (vertical jump), speed (10 m and 40 m sprint), and maximal aerobic power (multistage fitness test). Data were also collected on match frequency, training status, playing experience, and employment related physical activity levels.**

***Results*—The 10 m and 40 m sprint, vertical jump, percentage body fat, and multistage fitness test results were 20–42% poorer than previously reported for professional rugby league players. Compared with forwards, backs had significantly (p<0.01) lower body mass (79.7 (74.7–84.7) kg *v* 90.8 (86.2–95.4) kg) and significantly (p<0.01) greater speed during the 40 m sprint (6.45 (6.35–6.55) *v* 6.79 (6.69–6.89) seconds). Values for percentage body fat, vertical jump, 10 m sprint, and maximal aerobic power were not significantly different (p>0.05) between forwards and backs. When compared with professional rugby league players, the training status of amateur rugby league players was 30–53% lower, with players devoting less than three hours a week to team training sessions and about 30 minutes a week to individual training sessions. The training time devoted to the development of muscular power (about 13 minutes a week), speed (about eight minutes a week), and aerobic fitness (about 34 minutes a week) did not differ significantly (p>0.05) between forwards and backs. At the time of the field testing, players had participated, on average, in one 60 minute match every eight days.**

***Conclusions*—The physiological and anthropometric characteristics of amateur rugby league players are poorly developed. These findings suggest that position specific training does not occur in amateur rugby league. The poor fitness of non-elite players may be due to a low playing intensity, infrequent matches of short duration, and/or an inappropriate training stimulus.**

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Rugby league is a body contact sport played at amateur, semiprofessional, and professional levels.[1,2] A typical senior rugby league match lasts 60–80 minutes, with frequent intense bouts of running and tackling, interspersed with short bouts of recovery.[2–5] Hence, rugby league is physically demanding, requiring players to draw upon a variety of fitness components including (but not limited to) aerobic power,[6–8] speed,[6–9] and muscular power.[10–12]

Investigations of professional rugby league players have reported mean 10 m and 40 m sprint times of 1.71 seconds and 5.32 seconds respectively.[10] Estimates of maximal aerobic power ($\dot{V}O_{2}MAX$) have been in the range 48.6–67.5 ml/kg/min.[7,9,13,14] Despite having contrasting matchplay activities,[15] the physiological profile of professional rugby league forwards and backs is remarkably similar,[9,14] suggesting that fitness training for professional rugby league is uniform for all positions.[9] Indeed, most studies have reported similar muscular[7,9,14] and aerobic power[6,9,14] between professional rugby league forwards and backs. However, backs are reported to be lighter,[6,14,16] leaner,[7,14,16] and have faster 10 m, 20 m, and 40 m sprint times than forwards.[6,7,9,14]

It has been shown that first class rugby union players have superior muscular strength, endurance, and power to second class players.[17] Significant differences have also been reported between elite and non-elite Gaelic football players for muscular power, speed, and aerobic power.[18] These results suggest that fitness requirements differ according to the level of competition.[17,18] However, these findings may also be attributed, at least in part, to the poorly developed training habits of non-elite football players.[19] While investigators have developed physiological and anthropometric profiles of professional rugby league players,[6,7,9,14,16] similar studies have not been performed in amateur rugby league players. Therefore, the purpose of this study was to investigate the physiological and anthropometric characteristics of amateur rugby league players.

Methods

SUBJECTS

Thirty five healthy men with a mean (SD) age of 26.5 (5.1) years volunteered for this study. All subjects were registered players from the same amateur rugby league competition and were not receiving training or match payments. Before participation, each subject successfully completed a thorough health risk screening process[20] without any clinically significant findings. All subjects received a clear explanation of the study, including the risks and benefits of participation, and written consent was obtained. The Griffith University ethics committee approved all experimental procedures.

PROCEDURE

All field testing was conducted during the competitive phase of the rugby league season[7] by an independent investigator who was not affiliated with any of the registered teams. Following approval from the administrators of the amateur rugby league competition, team coaches and/or managers were contacted by the investigator to determine their willingness to participate in the study. Three of the four registered teams volunteered to participate, with the fourth team withdrawing because of players' employment commitments. A mutual time was then arranged for conducting the field testing. Coaches stated that they were prepared to devote one training session (about 90 minutes) to the field testing. While consideration was given to the specificity of the field test, the selection of tests included in the field testing battery was influenced by this time constraint.

FIELD TESTING BATTERY

Standard anthropometry (height, body mass, and sum of four skinfolds), speed (10 m and 40 m sprint),[7 9] muscular power (vertical jump),[21] and maximal aerobic power (multistage fitness test)[22] were the field tests selected. Subjects also completed a brief questionnaire documenting match frequency, training status, playing experience, and employment related physical activity levels. All subjects had performed the experimental procedures on a number of occasions before the field testing session. Players were requested to refrain from strenuous exercise for at least 48 hours before the field testing session. At the beginning of the field testing session, subjects were randomly allocated to two groups, consisting of approximately equal numbers of forwards and backs. Subjects in group 1 were measured for height and body mass while sum of skinfolds were recorded for group 2. Measurements of muscular power and speed were conducted in a similar manner, with group 1 performing the vertical jump and group 2 performing the 10 m and 40 m sprint. At the completion of anthropometric, speed, and muscular power tests, the field testing session was concluded with subjects performing the multistage fitness test (maximal aerobic power).

ANTHROPOMETRY

As an estimate of body fat, skinfold thickness was measured at four sites using a Harpenden skinfold caliper. Biceps, triceps, subscapular, and suprailiac on the right side were the four sites selected. The exact positioning of each skinfold measurement was in accordance with procedures described by Draper *et al*.[21] Percentage body fat was calculated from skinfold measurements using the procedures outlined by Durnin and Womersley.[23] Height was measured to the nearest 0.1 cm using a stadiometer, and body mass was measured to the nearest 0.1 kg using analogue scales (Seca, Hamburg, Germany).

MUSCULAR POWER

Lower leg muscular power was evaluated by the vertical jump test.[21] A board covering a 150 cm vertical distance was mounted to a wall during the vertical jump test. Subjects were requested to stand with feet flat on the ground, extend their arm and hand, and mark with chalk, the highest point reached. After assuming a crouch position, each subject was instructed to spring upward and touch the wall mounted board at the highest possible point. Vertical jump height was calculated as the distance from the highest point reached during standing and the highest point reached during the vertical jump. Vertical jump height was measured to the nearest 0.1 cm with the average value obtained from two trials used as the vertical jump score. The intraclass correlation coefficient for test-retest reliability[24] and technical error of measurement[25] for the vertical jump test were 0.93 and 4.54% respectively.

SPEED

The speed of subjects was evaluated with a 10 m and 40 m sprint[7] using electronic timing gates (Speed Light model TB4, serial no 4921001; Southern Cross University Technical Services, Lismore, Australia). The timing gates were positioned 10 m and 40 m cross wind from a predetermined starting point. On the command, subjects sprinted from a standing start.[14] They were instructed to run as quickly as possible along the 40 m distance. Speed was measured to the nearest 0.01 second with the average value obtained from two trials used as the speed score. The intraclass correlation coefficient for test-retest reliability[24] and technical error of measurement[25] for the 10 m and 40 m sprint tests were 0.86 and 0.89 and 2.31% and 1.52% respectively.

MAXIMAL AEROBIC POWER

Maximal aerobic power was assessed using the multistage fitness test.[22] Subjects were required to run back and forth—that is, shuttle run—along a 20 m track, keeping in time with a series of audible signals on a cassette. Each minute, the frequency of the audible signals (and hence running speed) was progressively increased, until subjects reached volitional exhaustion. $\dot{V}O_2MAX$ was estimated using regression equations described by Ramsbottom *et al*.[26] When compared with treadmill determined $\dot{V}O_2MAX$, it has been shown that the multistage fitness test provides a valid estimate of maximal aerobic power.[26]

COACH QUESTIONNAIRE

Coaches were requested to complete a brief questionnaire documenting the training time devoted to the development of muscular power, speed, and aerobic fitness. Coaches were also asked to document the training time devoted specifically to rugby league skills involving (*a*) continuous physical activity—for example, tackling drills, attacking plays—or (*b*) no physical activity—for example, team discus-

Table 1 Anthropometric characteristics of amateur rugby league forwards and backs

	Forwards	Backs
Age (years)	28.6 (26.7–30.5)	24.2 (21.7–26.7)*
Height (cm)	178.4 (174.5–182.3)	178.0 (175.4–180.6)
Mass (kg)	90.8 (86.2–95.4)	79.7 (74.7–84.7)*
Sum of four skinfolds (mm)	52.4 (45.8–59.0)	46.1 (37.0–55.2)
Estimated body fat (%)	19.9 (18.2–21.6)	17.5 (15.0–20.0)

Values are reported as means (95% CI).
*p<0.01, compared with forwards.

Table 2 Vertical jump, estimated $\dot{V}O_2MAX$, 10 m and 40 m sprint times for amateur rugby league forwards and backs

	Forwards	Backs
Vertical jump (cm)	37.1 (33.7–40.5)	39.3 (36.1–42.5)
10 m sprint (s)	2.62 (2.57–2.67)	2.53 (2.43–2.63)
40 m sprint (s)	6.79 (6.69–6.89)	6.45 (6.35–6.55)*
Estimated $\dot{V}O_2MAX$ (ml/kg/min)	38.11 (35.41–40.81)	40.04 (37.84–42.24)

Values are reported as means (95% CI).
*p<0.01, compared with forwards.

sions, game plans, and tactics. In addition, coaches were asked to estimate the amount of time devoted to position specific ("forwards only" or "backs only") training activities. Coaches were required to provide training information that corresponded to the stage of season when the field tests were performed.

STATISTICAL ANALYSIS

Data were collected from 19 forwards (lock = 4, second row = 10, prop = 4, hooker = 1) and 16 backs (fullback = 3, wing = 3, centre = 6, five-eighth = 2, halfback = 2). Differences in the physiological and anthropometric characteristics and training status of forwards and backs were compared using independent *t* tests. The level of significance was set at $p<0.05$, and data are reported as mean and 95% confidence intervals (CI).

Results

ANTHROPOMETRIC CHARACTERISTICS

Table 1 gives the anthropometric characteristics of the amateur rugby league forwards and backs. The mean (95% CI) height, body mass, and percentage body fat of all subjects was 178.2 (175.8 to 180.6) cm, 85.8 (80.6 to 91.0) kg, and 18.8 (17.3 to 20.3)% respectively. Forwards were significantly older ($p<0.01$) and significantly heavier ($p<0.01$) than backs. There were no significant differences ($p>0.05$) between forwards and backs with respect to height, sum of skinfolds, or estimated body fat.

MUSCULAR POWER, SPEED, AND MAXIMAL AEROBIC POWER

Table 2 gives the results of the muscular power (vertical jump), speed (10 m and 40 m sprint), and maximal aerobic power tests (multistage fitness test). The mean (95% CI) vertical jump, 10 m and 40 m sprint, and estimated $\dot{V}O_2MAX$ scores for all subjects were 38.1 (35.7 to 40.5) cm, 2.58 (2.51 to 2.65) seconds, 6.63 (6.53 to 6.73) seconds, and 38.98 (37.18 to 40.78) ml/kg/min respectively. Scores for vertical jump were not significantly different ($p>0.05$) between forwards and backs. Although backs were faster than forwards during the 10 m sprint, the difference was not significant ($p = 0.07$). Backs were significantly faster ($p<0.01$) than forwards during the 40 m sprint. No significant differences ($p>0.05$) were observed between forwards and backs for estimated $\dot{V}O_2MAX$.

PLAYING EXPERIENCE, TRAINING STATUS, AND EMPLOYMENT RELATED PHYSICAL ACTIVITY LEVELS

Table 3 gives the playing experience, training status, and employment related physical activity levels of amateur rugby league forwards and backs. The mean (95% CI) playing experience of all subjects was 11.2 (8.6 to 13.8) years. Subjects spent 3.5 (3.2 to 3.8) hours a week training for rugby league. They spent less than 3 (2.8 to 3.0) hours a week in team training sessions and about 30 (15.9 to 47.7) minutes a week in individual training sessions. In addition, subjects spent 17.7 (11.0 to 24.4) hours a week in other employment related physical activities. No significant differences ($p>0.05$) were observed between forwards and backs with respect to playing experience, training status, or employment related physical activity levels.

COACH QUESTIONNAIRE

Table 4 gives the mean (95% CI) training time devoted to the development of muscular power, speed, and aerobic fitness. About 26.4% (44.2–49.0 minutes a week) of the total training time was devoted to rugby league skills involving continuous activity. Subjects devoted 12.5 (11.6 to 13.4), 8.2 (6.0 to 10.4), and 34.4 (30.7 to 38.1) minutes a week to activities designed to enhance muscular power, speed, and aerobic fitness respectively. No significant differences ($p>0.05$) were observed between forwards and backs for the amount of training time devoted to skills training, or the development of muscular power, speed, and aerobic fitness.

MATCH FREQUENCY

At the time of the field testing, players had competed in three to six fixture matches, each of 60 minutes duration. A total of 12 fixture matches were scheduled for the season. On

Table 3 Playing experience, training status, and employment related physical activity levels of amateur rugby league forwards and backs

	Forwards	Backs
Playing experience (years)	12.4 (8.5–16.3)	9.8 (6.5–13.1)
Total training status (hours a week)	3.3 (3.0–3.6)	3.6 (3.1–4.1)
Team training sessions (number a week)	1.9 (1.8–2.0)	1.9 (1.7–2.1)
Team training sessions (hours a week)	2.9 (2.8–3.0)	2.8 (2.5–3.1)
Individual training sessions (hours a week)	0.4 (0.1–0.7)	0.8 (0.4–1.2)
Employment related physical activity (hours a week)	18.7 (9.7–27.7)	16.6 (6.3–26.9)

Values are reported as means (95% CI).

Table 4 Time devoted to various training activities for amateur rugby league forwards and backs

	Forwards	Backs
Muscular power (min/week)	12.9 (11.9–13.9)	12.1 (10.7–13.5)
Speed (min/week)	7.7 (4.6–10.8)	6.3 (3.0–9.6)
Aerobic fitness (min/week)	33.5 (28.5–38.5)	30.6 (24.9–36.3)
Rugby league skills (min/week)	46.4 (43.7–49.1)	45.1 (41.0–49.2)
No physical activity (min/week)	11.6 (9.6–13.6)	11.9 (9.7–14.1)
Other activities (min/week)	63.2 (56.9–69.5)	65.2 (58.1–72.3)

Values are reported as means (95% CI).

Table 5 Frequency of matches for amateur rugby league forwards and backs

	Forwards	*Backs*
Fixture matches played (number)	4.4 (3.8–5.0)	4.6 (4.0–5.2)
Match frequency (number a week)	0.89 (0.84–0.94)	0.86 (0.81–0.91)
Recovery between matches (days)	8.0 (7.6–8.4)	8.2 (7.8–8.6)

Values are reported as means (95% CI).

average, players had participated in one match every eight days (0.87 (0.84 to 0.90) matches a week) (table 5).

Discussion

This study investigated the physiological and anthropometric characteristics of amateur rugby league players. When compared with previously published results for professional players,[6 7 9 10 13 14] estimates of maximal aerobic power (38.98 *v* 67.5 ml/kg/min), 10 m (2.58 *v* 1.71 seconds) and 40 m (6.63 *v* 5.32 seconds) speed, and muscular power (38.1 *v* 54.2 cm) were lower, and percentage body fat higher (18.8% *v* 13.0 %) in amateur rugby league players. Values for percentage body fat, vertical jump, 10 m sprint, and maximal aerobic power were not significantly different between forwards and backs. The results of this study show that the physiological and anthropometric characteristics of amateur rugby league players are poorly developed. Furthermore, these findings suggest that position specific training does not occur in amateur rugby league. The poor fitness of non-elite players may be due to a low playing intensity, infrequent matches of short duration, and/or an inappropriate training stimulus.

This study of amateur rugby league players found an estimated $\dot{V}O_2$MAX of 38.98 ml/kg/min, a value 20–42% lower than previously reported for professional rugby league players.[7 13] Furthermore, the estimated $\dot{V}O_2$MAX was lower (≈20%) than regional (and national) representative rugby league players following six weeks of detraining.[27] The observation of poor aerobic fitness in the present sample of amateur rugby league players is to be expected, given that the training status of subjects was also poor (3.5 hours a week). Indeed, the training status of the amateur rugby league players was about 30–53% lower than recently reported for professional rugby league players (5.0–7.5 hours a week).[28 29] Furthermore, the training time spent in aerobic activities was also considerably lower than currently recommended for the development and maintenance of aerobic fitness.[30] It could therefore be suggested that the duration of the training stimulus employed by amateur rugby league players was inadequate to induce significant peripheral and/or central adaptations for improvements in $\dot{V}O_2$MAX. Alternatively, the low estimated $\dot{V}O_2$MAX in the amateur rugby league players of this study suggests that the volume and intensity of training may differ between amateur and professional rugby league.

When compared with professional competitors,[7] the present study found that measurements of speed and muscular power were lower, and percentage body fat higher, in amateur rugby league players. Indeed, the respective values for the 10 m sprint, 40 m sprint, vertical jump, and percentage body fat were 34%, 20%, 30%, and 31% poorer than previously reported for professional rugby league players.[7 10] It is highly likely that the elevated percentage body fat contributes to the inferior speed and muscular power of amateur rugby league players by attenuating the power to body mass ratio and therefore reducing performance in match specific tasks.[31] Alternatively, the poor vertical jump, 10 m and 40 m sprint results, coupled with the training time devoted to these fitness components (table 4), suggest that fitness training designed to increase speed and muscular power is not a priority in amateur rugby league.

Consistent with results of professional rugby league players,[7 14] the present study of amateur players found that when compared with forwards, backs had lower body mass and greater speed during a 40 m sprint. However, values for muscular and aerobic power and percentage body fat were similar between forwards and backs. The finding of superior 40 m speed in backs would be expected given that forwards rarely are required to run further than 10 m in a single bout of intense activity.[6] Similarly, when compared with backs, forwards spend significantly more playing time involved in tackles[15] and physical collisions,[13 28] so it is likely that the larger body mass of forwards assists in the development of greater impact forces associated with these events. While some position specific differences were detected between forwards and backs, these differences do not appear to be related to contrasting training patterns (table 4). Rather, these results suggest that position specific training does not occur in amateur rugby league and, as with professional rugby league, fitness training appears to be uniform for all positions.[9]

At the time of the field testing, the amateur rugby league players were participating (on average) in approximately one rugby league match every eight days (range 7–9 days). In addition, compared with professional rugby league,[1 5 15 28 29] the duration of matches was relatively short (60 *v* 80 minutes). Given that the greatest physiological adaptation would be expected to occur in response to playing rugby league,[15] the poor physical fitness of the amateur rugby league players is to be expected. Indeed, the poor physiological and anthropometric characteristics of the present sample of amateur rugby league players may be attributed, at least in part, to infrequent matches of short duration and the lower playing intensity at the non-elite level.[5 28] The present study investigated rugby league players who competed within the same amateur rugby league competition. It is possible that players from other amateur rugby league competitions, who play more matches of longer duration, may have superior fitness to the amateur players of the present study. In addition, it is possible that, had the present sample of amateur players been regularly competing in matches of longer duration, or tested after developing a greater degree of match fitness, the physiological and anthropometric characteristics obtained may have been superior to the present findings. However, given the large differences (20–42%) between amateur and professional rugby league players, it appears unlikely that alterations in match frequency and duration would result in comparable physiological and anthropometric characteristics between elite and non-elite competitors.

The sample size of this study is comparable with most professional rugby league studies.[6 9 10 14 27] However, compared with the study of O'Connor,[7] the present sample size is relatively small. In an attempt to obtain a homogeneous sample of amateur rugby league players, only subjects who regularly participated in training sessions and matches were investigated. Although it may have been advantageous to investigate a larger sample of subjects, it was considered more important to gain a representative sample of competitive amateur rugby league players. Indeed, if non-competitive amateur rugby league players were included in the field testing, the physiological and anthropometric characteristics could be expected to be significantly poorer than the present findings.

In conclusion, when compared with professional players, estimates of maximal aerobic power, speed, and muscular power were lower, and percentage body fat higher in amateur rugby league players. Values for percentage body fat, vertical jump, 10 m sprint, and maximal aerobic power were not significantly different between forwards and backs. The results of this study show that the physiological and anthropometric characteristics of amateur rugby league players are poorly developed. Furthermore, these findings suggest that position specific training does not occur in amateur rugby league. The poor fitness of non-elite players may be due to a low playing intensity, infrequent matches of short duration, and/or an inappropriate training stimulus.

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Take home message

This study has found that the physiological and anthropometric characteristics of amateur rugby league players are poorly developed. Estimates of maximal aerobic power, speed, and muscular power were considerably lower than previously reported for professional rugby league players. These results suggest that amateur rugby league players may benefit from structured strength and conditioning programmes.